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METHODOLOGY USED TO ESTIMATE FIRST-STAGE ELEMENTS OF THE TRANSITION PROBABILITY MATRICES FOR DYNAMOD II--TEACHERS AND EXTRA-SYSTEM FLOWS.

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THIS NOTE IS A CONTINUATION OF THE DISCUSSION PRESENTED IN EA 001 016. HERE, THE REMAINING INTRA-SYSTEM FLOWS (THE RETENTION OR TRANSFER OF PEOPLE WHO ARE PRESENTLY IN THE SYSTEM) ARE DESCRIBED. IN ADDITION, EXTRA-SYSTEM FLOWS ARE DESCRIBED. PROBABILITY MATRICES ARE DEVELOPED BY COMBINING, BY SEX AND RACE, TWO OCCUPATION MATRICES WITH AGE TRANSITION PROBABILITIES, RESULTING IN FOUR SEX-RACE-AGE-OCCUPATION MATRICES. DYNAMOD II CALCULATIONS ARE MADE FROM THESE MATRICES. THE INTRA-SYSTEM FLOW ESTIMATES DESCRIBED IN THIS NOTE ARE FROM COLLEGE STUDENT, ELEMENTARY SCHOOL TEACHER, SECONDARY SCHOOL TEACHER, COLLEGE TEACHER, AND OTHER (A RESIDUAL CATEGORY) TO ELEMENTARY SCHOOL TEACHER, SECONDARY SCHOOL TEACHER, COLLEGE TEACHER, AND OTHER. THE EXTRA-SYSTEM FLOW ESTIMATES INCLUDE THE FLOW FROM OTHER TO ELEMENTARY SCHOOL STUDENT, SECONDARY SCHOOL STUDENT, COLLEGE STUDENT, ELEMENTARY SCHOOL TEACHER, SECONDARY SCHOOL TEACHER, COLLEGE TEACHER, AND OTHER. (HW)

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NATIONAL CENTER FOR EDUCATIONAL STATISTICS
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METHODOLOGY USED TO ESTIMATE FIRST-STAGE ELEMENTS OF THE TRANSITION PROBABILITY MATRICES FOR DYNAMOD II: TEACHERS AND EXTRA-SYSTEM FLOWS

by

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INTRODUCTION

Background

This note is essentially a continuation of the discussion presented in Technical Note 28.[1/] where the methodology employed for calculation of dropout and retention rates for students was the focal point.

The remaining intra-system flows (i.e., the retention or transfer of people who are presently in the system), are described in this paper. In addition, extra-system flows, defined herein as flows of people from the "other" category to the educational system, are described. The probabilities estimated by the procedures described in this note are identified in table 1.

In the table, cells shown as "0" are those for which specific zero entries were recorded. As an example of how to read the table, refer to row 3, column 4. The number corresponding to the "X" entry is the estimated probability that a college student in one year will be an elementary school teacher the next year. It should be noted that the "X" entries in the "other" column are residuals, representing the difference between the required row sum of one and the total of the remaining entries in that row.

1/ E. K. Zabrowski and J. T. Hudman, Dropout and Retention Rate Methodology Used to Estimate First-Stage Elements of the Transition Probability Matrices for DYNAMOD II, April 20, 1967.

Table 1.--Transition probability estimates described in this Technical Note [1]

- Status this year -	-Status next year- Elementary school student	Secondary school student	College student	Elementary school teacher	Secondary school teacher	College teacher	Other	Dead [2]
Elementary school student			0	0	0	0		
Secondary school student	0			0	0	0		
College student	0		0	X	X	X		
Elementary school teacher	0	0	0	X	0	0	X	
Secondary school teacher	0	0	0	X	X	0	X	
College teacher	0	0	0	X	X	X	X	
Other	X	X	X	X	X	X	X	

1/ Estimates specifically described in this note are designated with an "X". Estimates for which no transitions were permitted are designated with an "0."

2/ The procedures used for estimating death rates are described in T. Okada, Birth and Death Projections Used in Present Student-Teacher Population Growth Models, Technical Note No. 11, December, 1966.

The matrix presented in table 1 describes only the probabilities of transfers from one "OCCUPATION" to another. As the first of a two-step procedure to arrive at the final matrices used in DYNAMOD II, two such matrices were built, one for males and one for females respectively.

To obtain the probability matrices used in the computer runs of DYNAMOD II, the two occupation matrices were combined with age transition probabilities by sex and race, resulting in four sex-race-age-occupation matrices from which the DYNAMOD II calculations were made.

Teacher data were not usually available in the form most suitable for making estimates of transition probabilities. However, approximations were considered to be acceptable, since adjustments could be made to the first-stage estimates by cycling the entire model.[2/] Actual data values are presented in this note in those sections where they would enhance or clarify the discussion. Since the results of these efforts yielded trial probabilities that were changed almost immediately, the repeatibility criterion is not considered essential to the validity of this paper. For this reason, the first-stage probability matrices are not presented.

2/ Preliminary cycling of the model also was necessary because the data used in developing the probabilities came from many sources, most of which were based on samples. The sampling error alone would have been enough to require adjustments to the model.

Notation

The notation used in this paper is much the same as that followed in TN-28. Specifically, the abbreviations below designate the particular population groups that are used in the development of the transition probability estimates:

1. CS - college student;
2. ET - elementary school teacher;
3. ST - secondary school teacher;
4. CT - college teacher;
5. O - Other, i.e., neither student nor teacher.

The designation P(I→J) means "the probability that an individual who is in group I in time t is in group J in time t+1." For example, P (CS→CT) refers to the probability that a person who was a college student (group I) in a given year, (t), becomes a college teacher (group J) the next year, (t+1).

ESTIMATES OF INTRA-SYSTEM FLOWS

College Students Entering Teaching

College students entering teaching were assumed for purposes of the trial estimates, to be holders of bachelor degrees (B), master degeees (M), or doctorates (D). The trial estimates described in this section are:

P(CS→CT)
P(CS→ST)
P(CS→ET)

Table 2 presents the estimates of the numbers of college students entering teaching in 1960 by degree level, teaching level, and sex. The remainder of this section describes how the estimates were developed.

Table 2.-Estimated number of college students entering teaching, by level of degree and sex,1960

Teaching level	Male			Female		
	Bach. and first prof.	Masters	Doctorate	Bach. and first prof.	Masters	Doctorate
College	5,800	6,922	3,329	1,951	2,299	887
Secondary	31,810	11,058	315	23,654	5,673	59
Elementary	7,384	2,292	55	38,317	6,875	41

Source: Application of percentages described in text to data published in OE-54013-60 (see footnote 9 of text).

The required probabilities were derived by dividing the number going into a teaching level by the number of college students, according to their respective sexes.

The development of the probability estimates required the commingling of several data sources, and consequently, the introduction of several intermediate steps to render the sources compatible.

The data source used for bachelor's and master's degree recipients contained information on flows into teaching by sex, but with a difference of two years between the time the degrees were conferred and when the survey was conducted.[3/] These values are shown in the first six columns of table 3.

Estimates of new doctorate flows into teaching. Information regarding the number of new doctorates flowing into teaching was even scarcer than for the baccalaureate and master's levels. Data were found on the total number of new doctorates going into college teaching

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3/ National Science Foundation, Two Years After the College Degree, NSF 63-26. Washington, D. C.: U. S. Government Printing Office, 1963. Data for bachelor's degree recipients were taken from table 32. Master's degree data were available in table 54. Those receiving "professional" degrees (M.D., D.D.S., D.V.M., LL.B., and B.D.) were not included in the DYNAMOD II estimates because the very small numbers involved in the sample were considered to be insignificant for the purpose required.

and into elementary plus secondary teaching (column 7 of table 3).[4] The same document contained data on the number of doctorates awarded by sex (columns 8 and 9 of row 1, table 3),[5] but cross-classifications of this information were not presented. The problem in estimating the new doctorate flow into elementary, secondary, and college teaching therefore, was the development of these cross-classifications.

Elementary and secondary school entry data from the other sample on bachelor's and master's degree recipients (footnote 3) were first combined to present a consistent data base for making estimates of the new doctorate flows into the three levels of teaching. It was then hypothesized that, the higher the degree level attained (and hence, on the average, the longer the time required to obtain a given degree) the greater would be the propensity to enter a higher level of teaching. Further, it was suspected that this propensity to enter the higher levels of teaching would be nonlinear, because of the extra efforts and sacrifices involved. That is, it was suspected that if it took twice as long to get a doctorate as it did a master's degree, the propensity of new doctorates to enter college teaching would be more than twice that of the master.

4/ National Academy of Sciences - National Research Council, Doctorate Production in United States Universities, 1920-62, Publication 1142, Washington, D. C., 1963, table 25.

5/ Ibid., table 26.

Table 3.-Post-degree occupational destinations of college graduates, by degree level and sex, and ratio of graduates entering college teaching to those entering elementary or secondary teaching, 1960

	Degree level								
	Bachelor 1/			Master 1/			Doctorate 2/		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
All respondents	32,122	20,399	11,723	5,869	4,025	1,844	10,000	8,910	1,090
Teaching:									
College	628	464	164	727	547	180	4,312		
Secondary	4,529	2,540	1,989	1,318	874	444	481		
Elementary	3,812	589	3,223	719	181	538			
Other	23,153	16,806	6,347	3,105	2,423	682	5,207		
Ratio of college to elementary and secondary 3/	.0753	.1483	.0315	.3569	.5185	.1833	8.9647		

1/ From: Two Years After the College Degree, op. cit. These data apply to a sample of June, 1958, graduates who were surveyed in May, 1960, and do not represent universe estimates.

2/ From: Doctorate Production in United States Universities, 1920-1962, op. cit.

3/ Figures are to be read on an "is to one" basis. For example, under doctorates the figure is 8.9647:1.

One problem in testing the hypothesis was how to account for time differences in achieving various degree levels. Since most masters and doctorates obtain a bachelor degree before going on for advanced study, it seemed plausible to start with bachelor degrees as a datum and then obtain estimates of the time spacing between the bachelors and the other advanced degrees.

It would have been ideal for purposes of time spacing to have the mean times to completion for masters and doctorates. One study provided information on the mean time to completion of the doctorate, but data for the masters were not readily available.[6/]

In view of this lack of data, it was decided to develop the concept of "minimum likely" time to completion of the degree. Numerous college course catalogs were examined. It was found that it is possible, but not likely, to get a master's degree in nine months of study. Somewhat more likely was a period of one year, which would include graduate assistants who took slightly lighter loads because of their other duties. Similarly, a doctorate could be obtained in less than three years (i.e., two years beyond the master) beyond the baccalaureate, but three years seemed a much more plausible selection for a minimum likely time.

6/ Harvey B. Safeer, Scientific and Engineering Projection Cost Model (Preliminary Report to the Office of Science Resources Planning, National Science Foundation), Research Analysis Corporation, October, 1965.

The "minimum likely" times to completion of the degrees selected were one year beyond the bachelor for masters and two years beyond the master for the doctorate. The ratios of total college teaching entrants to total elementary plus secondary teaching entrants were plotted on semi-logarithmic paper (figure 1), to test the hypothesis. The three plotted points fell approximately on a straight line and it was decided to accept the hypothesis and to estimate the ratio of new doctorate college teaching entrants by sex by extrapolating the ratios from the bachelor's and master's levels shown in table 3, allowing for sampling fluctuations. The results of the extrapolations, taken from figure 1 were 9.0 for male and 6.1 for female new doctorates entering college teaching, to every one new doctorate of the respective sex entering elementary or secondary teaching.

The next step was to estimate, by sex, the ratio of new doctorates entering the specific elementary or secondary school teaching levels. Again a semi-logarithmic chart was used, this time to project the proportions of, say, male secondary school teaching entrants to male elementary school teaching entrants by degree level.[7/] This information for bachelor's and master's level entrants was available from the data in table 3 and was extrapolated to the doctorate level (figure 2). The results are shown in table 4. As indicated in table 4, it was

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7/ It was assumed that if the relationships shown in figure 1 were log-linear, these would be also.

Figure 1.-Ratio of college graduates entering college teaching to those entering elementary or secondary school teaching, by sex and degree level

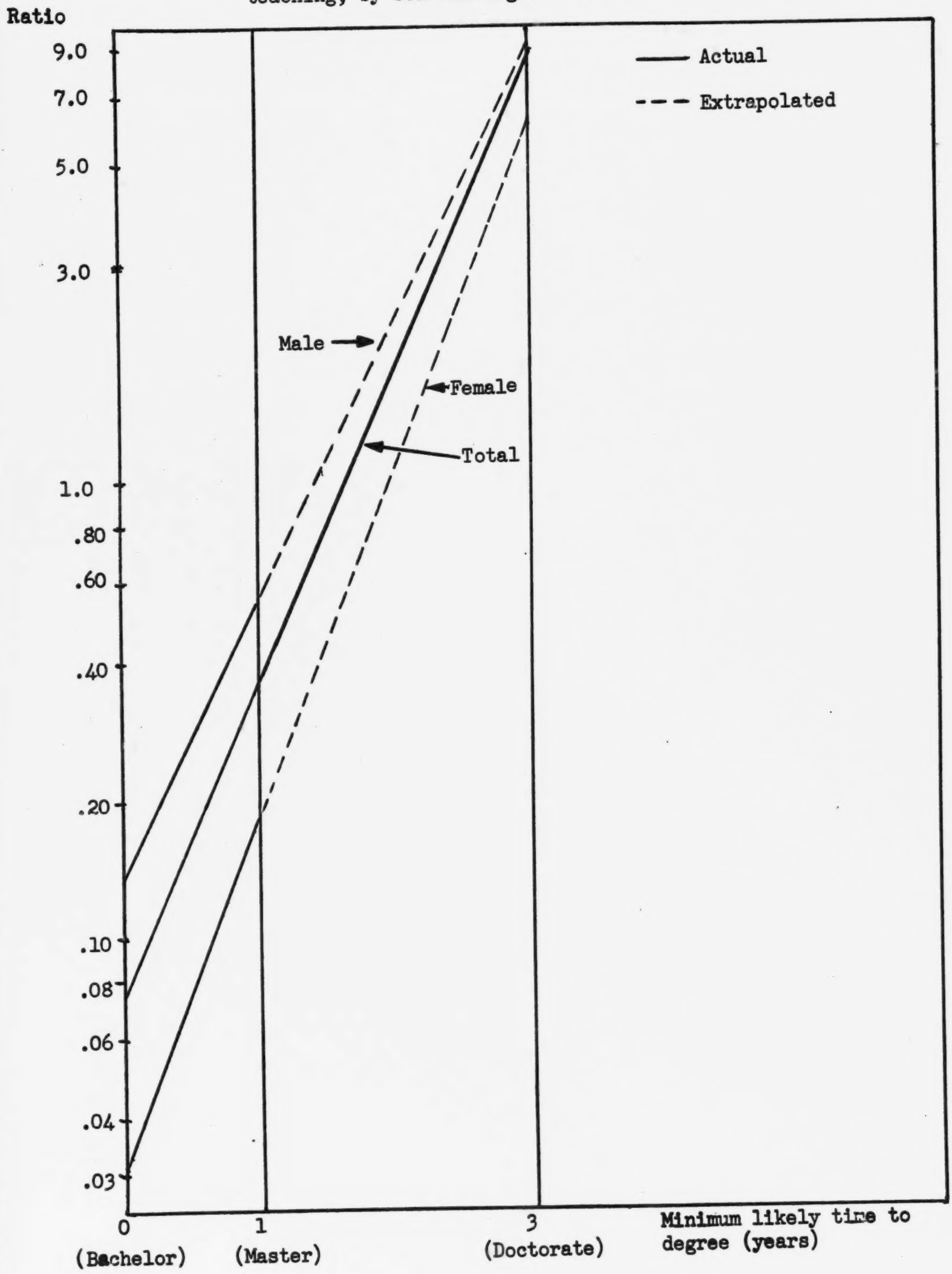
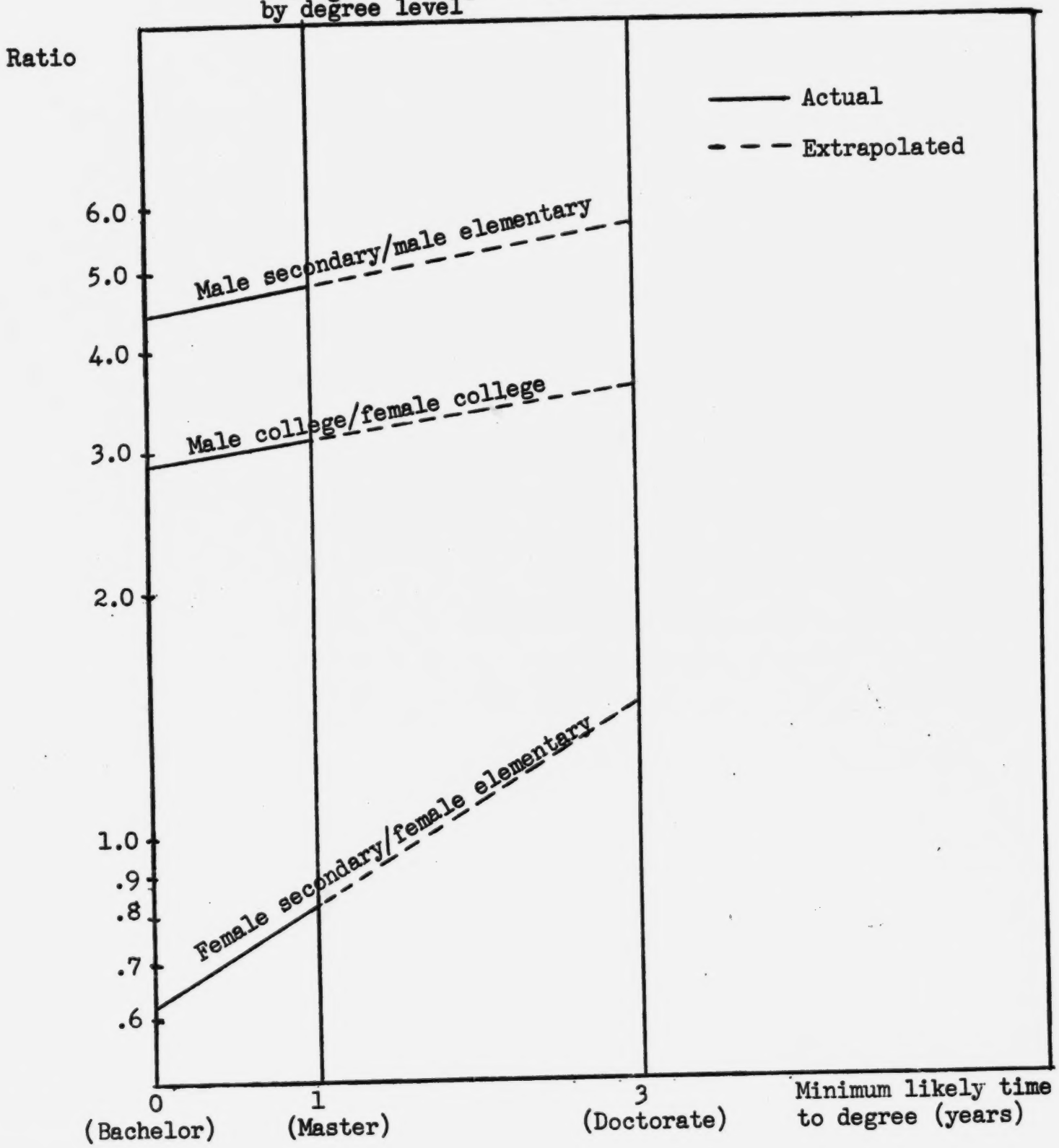


Figure 2.-Ratios of college graduates entering secondary school teaching to those entering elementary school teaching by sex, and ratio of male college graduates entering college teaching to females so entering, all ratios by degree level



estimated that, for every new male doctorate entering elementary school teaching, 5.68 new male doctorates entered secondary school teaching.

Next, the ratio of male to female college teacher entrants was computed by degree level for bachelor's and master's graduates, and extrapolated by semi-logarithmic chart to the doctorate level. The results, also shown in figure 2, were:

Degree level	Ratio of male to female college teaching entrants
Bachelor	2.8292:1
Master	3.0389:1
Doctorate	3.58:1 (Estimated)

These figures yielded enough information to complete the cross-classification of new doctorates. The 3.58 figure meant that, of every 4.58 new doctorates entering college teaching, 3.58, or 78.17 percent, were estimated to have been males. Applying that percentage to the table 3 sample data for the number of new doctorates entering teaching (4,312), gave 3,371 as the sample base estimate of the number of new male doctorates entering college teaching (table 5). From this estimate, and the ratio 9.0:1 from figure 1, the number of male new doctorates entering elementary and secondary school teaching were estimated to be 375. Then the remaining new male doctorates were allocated to elementary or secondary teaching on the basis of the figure (5.68:1) shown in table 4. Identical procedures were followed for new female doctorates, on the residual (481 - 375 = 106) allocable to females. (Note that the results would have varied slightly

Table 4.-Ratio of secondary to elementary school teaching entrants, by degree level and sex

Degree level	Ratio of secondary to elementary school teaching entrants	
	Male	Female
Bachelor[1/]	4.3124:1	.6171:1
Master[1/]	4.8287:1	.8253:1
Doctorate[2/]	5.68:1	1.45:1

1/ From table 3.

2/ Estimated from figure 2.

if females had been estimated first, and males taken as the residual.) Thus, the cross-classification of the sample base for both sexes as shown in table 5 was completed.

With the cross-classification of new doctorates completed, the next step was to take the data for bachelor, master, and doctorate entries in tables 3 and 5 and to express them as percentages of their respective degree totals, i.e., "all respondents" in the sample (table 6).[8] These percentages were then applied to the respective total degrees conferred for the aggregate United States for the 1959-60 academic year to obtain a degree-level teaching-entry data base, and then the degree-level teaching-entry base data were combined to obtain school level entry (elementary, secondary, and college) figures by sex.[9] That is, say, $CT = B_{CT} + M_{CT} + D_{CT}$, and so on. The final

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8/ A theoretically more acceptable way of deriving these percentages for bachelor and master degree recipients would have been to inflate those figures by the respective retention rates for the teaching level they entered, because of the extra year lag between the time they received their degrees and the time when they were surveyed. However, this was not done because the probabilities of entry were relatively small and the estimation error in the teacher retention rates was unknown. For males as an example, the original estimate of P(CS→ET) was .0045, and the P(ET→ET) was .9414. Inflating the former by the latter would have changed P(CS→ET) to .0048, or a trivial difference in a trial estimate.

9/ Wayne E. Tolliver, Earned Degrees Conferred, 1959-60, U.S. Office of Education, OE 54013-60, Circular No. 687, Washington, D.C., Superintendent of Documents, U.S. Government Printing Office, 1962, tables 1, 2 and 3. Bachelor degrees also include first professional degrees, which had a negligible effect on the estimates.

Table 5.-Estimated number of new doctorates entering teaching, by level of teaching and sex, 1960[1/]

Teaching level entered	Total	Male	Female
College	4,312	3,371	941
Secondary	382	319	63
Elementary	99	56	43

1/ Sample base data only: does not represent universe estimates. These figures are the apportionments to male and female new doctorates by level of teaching entries of the totals shown in the "Doctorate" column.

Table 6.-College graduates entering teaching as percent of total graduates, by degree level and sex

	Degree level					
	Bachelor		Master		Doctorate	
	Male	Female	Male	Female	Male	Female
All respondents 1/	100.00	100.00	100.00	100.00	100.00	100.00
Teaching:						
College	2.27	1.40	13.59	9.76	37.83	86.33
Secondary	12.45	16.97	21.71	24.08	3.58	5.78
Elementary	2.89	27.49	4.50	29.18	0.63	3.94

Source: Tables 3 and 5.

1/ "All respondents" in the samples were generalized to "Earned degrees conferred" for the purpose of making the estimates shown in table 2.

step was to divide the school level teaching entry figures (CS→CT), by the respective male-female degree-credit enrollment data for fall 1959.[10] The results of these divisions yielded the first-stage transition probabilities for males and females described at the beginning of this section.

College Teachers Transferring to Elementary or Secondary Education: P(CT→ET) and P(CT→ST)

The basic data sources used in developing the estimates of the probabilities that a college teacher in one year entered elementary or secondary school teaching the following year were unpublished data supplied by Office of Education personnel.[11]

10/ The figures originally used were 2,160,886 for males, and 1,216,387 for females, appearing in the "Opening Fall Enrollment in Higher Education" series of the U.S. Office of Education. This time series appears more conveniently in the Digest of Education Statistics, 1966 ed., OE-10024-66, Washington, D. C.: Superintendent of Documents, U.S. Government Printing Office, 1966, table 78. Male enrollments in the Digest are 7,321 students lower than those used for DYNAMOD II, and female enrollments are 5,091 lower. The effect is confined to the fourth decimal digits in the transition probabilities.

11/ These data were provided by the Higher Education Studies Branch, Division of Statistical Analysis, National Center for Educational Statistics. The figures came from a follow-up study conducted in 1964 of a survey of college and university teaching faculty conducted by OE in the spring of 1963. In the tables of the sample follow-up, transferees were listed as doctorate or nondoctorate, and the elementary and secondary education receiver categories were combined. The probability estimates were not adjusted for nonresponse because of the smallness of the percentages involved in college teachers leaving for elementary or secondary school teaching.

The basic data sources indicated that, of all college teaching leavers, 11 percent of the doctorates and 3 percent of the nondoctorates went into elementary or secondary teaching.

Estimates of the flows. The total number of doctorates entering elementary or secondary school teaching was estimated as follows:

(1) (Doctorates leaving college faculties) x (percent of leavers going to E or S) = number of doctorates leaving for E or S.

In examining the mobility data in the sample, it was noticed that the mobility rates tended to be highest in the younger age groups. In view of this, it was decided to apportion the college faculty leavers to elementary and secondary school teaching in the same manner as was done in table 2 for the (also young) college graduates entering these levels.

The estimates were made in two stages. First, the proportions of doctorate college leavers flowing to elementary plus secondary teaching were estimated, and then the proportion of doctorates flowing to elementary school teaching alone were estimated. To illustrate for male doctorates, the proportion of all doctorates leaving college teaching and entering elementary and secondary teaching who were males were estimated from table 2 to be

(2) $\frac{315 + 55}{315 + 55 + 59 + 41} = .7872$, and hence the accompanying female doctorate proportions were 1 - .7872, or .2128.

Then, the male doctorates entering secondary school teaching were estimated as a proportion of those in elementary plus secondary, as follows:

(3) $\frac{315}{315 + 55} = .8514$, with those going to the elementary school level being $1 - .8514 = .1486$

Thus it was estimated that if 1,000 doctorates left teaching, 787 would be males and .8514 X 787 = 670 would go the secondary school sector.

Similar estimates were derived for female doctorates, and for nondoctorates by sex. These estimated proportions were then applied to the doctorate/nondoctorate leaver figures from the basic data source to develop the required cross-classification of leavers by degree level and sex and the receiving teaching level.

The final step was to express the individual items in the cross-classification as a proportion of the totals for male and female college and university faculty in the original (1963) sample.[12/]

Retention of College Teachers: P(CT→CT)

The same data sources described in footnote 11 were utilized in preparing the estimates of the college teacher retention rates. The data indicated, by sex, the number of faculty in the spring of 1963 who were:

12/ Faculty leavers between the spring of 1963 and the fall of 1964 amounted to 13 percent of the total. Some obviously had left during the earlier part of the year, but the number was unknown. It was believed that most faculty members would have finished the academic year before leaving, so that the loss of accuracy was small.

(a) Not in higher education 1961-62;

(b) Not at same institution 1961-62; and

(c) At same institution 1961-62.

The probability estimate was derived as follows:

$$(4)\quad P(CT \rightarrow CT) = \frac{(b) + (c)}{(a) + (b) + (c)}$$

The sum (a) + (b) + (c) in the denominator was utilized for two reasons. First, these data were available by sex. Second, the nature of the data involved supplied an estimate close enough to that which was required, i.e., the numbers remaining divided by the original faculty. The original faculty could be estimated by taking (a) + (b) + (c), adding deaths, and subtracting a number estimated to support growth in enrollments, assuming leavers are replaced in the same year. The adjustments for deaths and enrollment growth were not made, which probably resulted in a small underestimate of the retention rate.

Retention of Elementary and Secondary School Teachers: P(ET→ET) and P(ST→ST)

In 1963, the Office of Education released a study of teacher turnover in the public schools.[13] The study presented data by sex and teaching level that were directly usable for public schools. However, no comparable data were available for nonpublic schools.

13/ Frank Lindenfeld, Teacher Turnover in Public Elementary and Secondary Schools, 1959-60, OE-2300-60, Circular No. 675, Washington, D. C., Superintendent of Documents, U.S. Government Printing Office, 1963.

Data for nonpublic schools were deemed important because many of the nonpublic school teachers are members of religious orders, and these teachers were assumed to have higher retention rates than the public school teachers.

It was decided to set up a five-step estimating procedure, wherein Roman Catholic school data would be used to adjust certain items in the teacher turnover data so as to take some account of these turnover differentials.[14] In outline form, the steps followed were (a) develop retention rates for the public school sector; (b) determine the proportion of laity in the Roman Catholic schools; (c) adjust the separations in the nonpublic schools to reflect the proportion of laity; (d) construct a table of "equivalents" to the public school system, with adjusted turnover data, and develop retention rates therefrom; and (e) combine public and nonpublic school data by a weighting procedure.

By following this procedure, the public school data could be used to estimate the probabilities in the nonpublic school sector (hence the term public school "equivalents"), thus in a sense creating data where none was available previously.

Public school retention rates. On the basis of the data pre-

14/ Reginald A. Neuwein, ed., Catholic Schools in Action, Notre Dame Study of Catholic Elementary and Secondary Schools in the United States, University of Notre Dame Press, 1966. In the 1960-61 academic year, Roman Catholic secondary schools accounted for 80.0 percent of all nonpublic secondary school enrollments. A comparison of Roman Catholic elementary school enrollment to the nonpublic elementary school total gives 91.5 percent (cf. Digest of Educational Statistics, op. cit., table 36, p. 31.

sented in Teacher Turnover, the following estimating relationship was established for each sex and level of school:[15]

(5) Teachers retained = Opening staff 1959 - Separations + Transfers.

From this formula were computed the probabilities of retention in the public schools:

$$(6)\quad P_{Pub}(T \rightarrow T) = \frac{\text{Teachers retained}}{\text{Opening staff}}$$

The trial probabilities were:

	Public Schools	
	Elementary	Secondary
Male	.9406	.9354
Female	.9158	.9008

15/ Teacher Turnover, op. cit., table 3, p. 9. Transfer to other schools were counted in separations and had to be added back to the opening staff.

Laity ratios. For purposes of computing the proportions of laity in the Catholic school systems, data were combined for the survey categories "Teacher" and "Teacher and Administrative." Males were presented in the report as "Priests," "Brothers," and "Layman," while females were presented as "Sisters" and "Laywoman."[16] Data for Priests and Brothers were combined, and the following percentages were obtained:

	Laity as percent of total staff, given sex	
	Elementary school	Secondary school
Male	64.53	44.19
Female	29.98	20.29

Of all male elementary Catholic school teachers, 64.53 percent (upper left hand corner) were of the laity.

Adjusted separation rates. The next step in establishing a table of public school equivalents was to relate the Catholic school data to the turnover accounts presented in Teacher Turnover, and to determine which entries in the turnover accounts required adjustment. Upon identification of the items, they were multiplied by the appropriate laity ratios to obtain the estimate of the public school equivalents.

The items selected from the turnover accounts were dismissals and transfers. It was reasoned that few, if any, of the nonlaity would be dismissed, and it was further reasoned that, on a year-to-year basis,

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16/ Catholic Schools in Action, op. cit., p. 82.

very few of the nonlaity would be transferred. It was assumed that the lay teachers would follow the behavior patterns of their counterparts in the public school systems.[17/] The adjustments to the Teacher Turnover data are presented in table 7.

Development of nonpublic school teacher retention rates. The transfers and separations as adjusted in table 6 were substituted into equation (5) to obtain the value of nonpublic school teachers retained, and from this was obtained:

$$(7)\quad P_{\substack{\text{non-}\\ \text{pub}}}\ (T \rightarrow T) = \frac{\text{Public teacher equivalents retained}}{\text{Opening staff}_{(\text{Pub})}}$$

The trial probabilities were:

	Nonpublic schools	
	Elementary	Secondary
Male	.9484	.9494
Female	.9246	.9153

17/ The reader is reminded at this point that the estimates being developed were only trial estimates for first-stage iterative purposes, and consequently no requirement was present for extreme accuracy.

Table 7.-Teacher Turnover data: published public school data and adjusted nonpublic school data

Adjusted item	Elementary				Secondary			
	Male		Female		Male		Female	
	1/ Public	2/ Nonpublic	1/ Public	2/ Nonpublic	1/ Public	2/ Nonpublic	1/ Public	2/ Nonpublic
Transfers	7.8	5.0	34.4	10.3	19.3	8.5	15.6	3.2
Separations	14.7	11.0	96.7	66.1	39.5	24.3	42.3	26.0

1/ From Teacher Turnover, op. cit., table 3.

2/ Obtained by multiplying the data in the immediate left-hand column by the appropriate laity ratio in Catholic schools. Catholic school data as of October, 1962.

Combination of public and nonpublic school teacher retention probabilities. The final step in the development of the retention probabilities was the combination of the respective public and nonpublic probability estimates just developed. This was accomplished by applying the formulas:

$$(8)\quad P_i(ET \rightarrow ET) = \sum_j W_{ij} P_{ij}$$

$$(9)\quad P_i(ST \rightarrow ST) = \sum_j W_{ij} P_{ij}, \text{ where}$$

i = 1, 2 for male, female;
j = 1, 2 for public, nonpublic;
P_{ij} = the retention probability estimated for the ijth group above;
W_{ij} = the relative weight of the ijth teaching group in its teaching level stratum; and
P_i = the retention probability for sex i.

The weights used, obtained from 1960 Census data, were:[18]

Elementary:	Teachers, 14 years or older	
	Male	Female
Public	.9020	.8263
Nonpublic	.0980	.1737
	1.0000	1.0000

[18] U.S. Department of Commerce, Bureau of the Census, Characteristics of Teachers (U.S. Census of Population, 1960), PC(2)-7D, table 1.

Secondary School Teachers Transferring to Elementary School Teaching: P(ST→ET)

Specific estimates of the probabilities of secondary school teachers transferring to elementary school teaching were not obtainable from the data at hand. It was strongly suspected that a notable flow from secondary to elementary teaching existed, however. Consequently, it was decided to make this estimate from the trial iterations of the two probability matrices.

This was accomplished by introducing the probabilities as "balancing" items between the underestimate of elementary school teachers and the excess in the number of secondary school teachers that could not be adjusted by changing the rate of flow from "other" to secondary school teaching (because of the discrete behavior of the "other" estimate, even in the fourth decimal digit).[19]

After two iterations, the probabilities of secondary school teachers transferring to elementary school teaching were:

Male	.0397
Female	.0431

Transfer to "Other"

College students and teachers leaving the educational system for the "other" category were estimated as having probabilities equal to 1.0000 minus all other entries in their respective rows of the matrices. Occasionally, as in the case of college dropouts, specific probabilities

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19/ This problem results from limitations in the computational method. It permits no more than four decimal places in input values. Normally, this is adequate; however, the "other" population group may contain up to 6.5×10^6, and when this number is multiplied by probabilities in increments of .0001, flow increments of 6500 are the result.

of the event were estimated for use in the development of other estimates. However, these probabilities were not shown separately in the matrices, to maintain consistency.

ESTIMATES OF EXTRA-SYSTEM FLOWS

This part of the note concentrates on the procedures used to estimate the transfers from the "other" category to the six levels of students and teachers representing the educational population. The transferees from "other" are many people--young children entering kindergarten or entering the first grade without having attended kindergarten, returning dropouts, returning teachers, and so on.

In no case was the development of these estimates a simple task. Not only were desirable data difficult to acquire but the "other" category was found to be very large (about 65 million males and 69 million females in 1960) relative to the receiver categories in most cases, making difficult the adjustments of these flows even at the fourth decimal digit of the transition probabilities. Again, however, the estimates were only trial figures that would have to be disaggregated by age after the initial iterations, and some error was to be tolerated.

Elementary School Students: P(O→ES)

Nearly all the transfers from "other" to the elementary school sector are the result of young children beginning their education. Entries to the system are composed of first-grade enrollees who had not previously attended kindergarten plus new kindergarten enrollments.[20] These estimated entries, by sex, were then divided by the respective numbers

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[20] The development of the estimates for the number of first-grade enrollees who had not previously attended kindergarten is discussed in Zabrowski and Hudman, Dropout and Retention Rate Methodology Used to Estimate First-Stage Elements of the Transition Probability Matrices for DYNAMOD II, Technical Note No. 28, April, 1967, equation (3).

in the "other" category the previous year to give the probabilities desired.[21]

Secondary School Students: P(0→SS)

Secondary school returnees were considered to consist primarily of dropouts from the previous year. The lack of data not only for returnees in general, but for dropout returnees in particular, required the development of broad assumptions. One recent survey indicated that, after a period of two years, 6 percent of all dropouts had returned to school.[22] Simple linearization of this estimate yielded a 3 percent figure for one year. Because of social pressures on males to complete their schooling, it was decided to use the 3 percent figure for their dropout return rate. However, the female dropout return rate was arbitrarily reduced to 2.5 percent, not only because of the relative lack of pressure to complete their educations, but also because many of them dropped out due to pregnancy and would not be able to return.

Dropouts were computed in accordance with previously-developed estimating formulas.[23] Then, the returning dropouts by sex were estimated from the calculated dropout figure. Finally, the estimated returnees were divided by the respective number of people in "other" to give the required trial probabilities.

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[21] These estimates were checked by a secondary procedure utilizing enrollment rates by age grouping. The comparisons were good, though not exact.

[22] Vera C. Perella and Elizabeth Waldman, Out of School Youth--Two Years Later, Special Labor Force Report No. 71, August, 1966, p. 861.

[23] Zabrowski and Hudman, op. cit., Appendix B.

College Students: P(O→CS)

Only one study was readily available that presented data on returning college students, and that study covered only one large midwestern university.[24] The sample was of more than 16 thousand students, however, and was deemed acceptable in lieu of the alternatives.

The first step consisted of expressing the number of reentry students in the sample plus 5 percent of those admitted with advanced standing as proportions of the enrollment totals.[25] Next, the enrollments by sex in all institutions of higher education were aggregated for 1961.[26] Then the proportions developed in the first step above were applied to the 1961 enrollments by sex to obtain the estimates of the number of reentering students by sex. Finally, the number of reentries was divided by the appropriate number in "other" to obtain the required probabilities.

24/ L. J. Lins, Methodology of Enrollment Projections for Colleges and Universities, Committee on Enrollment Projections, American Association of Collegiate Registrars and Admissions Officers, March, 1960, Table VI, p. 40.

25/ The 5 percent figure was an arbitrary adjustment in recognition of the fact that not all students admitted with advanced standing were transferees from in-state junior colleges or out-of-state colleges and universities as defined in the study. Reentry students as defined in the study were leavers who returned to the same school. No estimate was possible for the number of high school graduates who entered college after a delay, or for others who obtained high school equivalencies and went on to college.

26/ Office of Education, Projections of Educational Statistics to 1974-75, 1965 edition, OE-10030-65, table 4, p. 7.

Elementary and Secondary School Teachers: P(O→ET) and P(O→ST)

To estimate the probabilities that elementary or secondary school teachers who previously had left the field would re-enter teaching, a five-step procedure very similar to that described above for retention rates was employed.

From the basic data source were computed the ratios of "reentries" to college sector entries.[27] Next, an analogous set of nonpublic school ratios was developed by multiplying the public school ratios by the laity percentage. The third step consisted of establishing the relation

(10) $\bar{R}_{ik} = \sum_j W_{ijk} R_{ijk}$, where

$i = 1, 2$ for male, female;
$j = 1, 2$ for public, nonpublic;
$k = 1, 2$ for elementary, secondary
R_{ijk} = the re-entry ratio for the ijk group;
W_{ijk} = the relative weight of the ijk teaching group in its stratum; and
$\bar{R}_{ik}$ = the re-entry ratio for the ik stratum.

The W_{ijk} were the same as those used in equations (8) and (9) above.

Then, these ratios were applied to the appropriate entry figures described earlier to obtain numerical estimates of the reentering elementary and secondary school teachers. The final step was to divide the numbers obtained by the appropriate totals (by sex) in "other."

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[27] Teacher Turnover, op. cit. This form of estimate (without allowance for new entries) was required because no estimates of the number of new entries from the work force was available.

College Teachers: P(O→CT)

The key to developing the set of estimates of P(O→CT), i.e., re-entries plus delayed new entries, was in obtaining estimates of total entries and college graduates entering college teaching. Sample estimates of the male-female proportions of total entries were available from unpublished data sources.[28] These proportions then were applied to the data for total 1961-62 instructional staff for resident degree courses in higher education to obtain the estimates of total entries.[29] Next, the 1960 total fall enrollment figures by sex were multiplied by their respective probabilities, P(CS→CT), to obtain estimates of the 1961-62 college student entries to college teaching.[30]

The differences by sex in these two estimates were the estimates of the numbers of re-entries plus delayed new entries into college teaching. The final step consisted in dividing these estimates by the respective numbers in "other" to obtain the desired probabilities.

Retention in "Other"

As with similar row entries, the "other" column figure was estimated as the residual between 1.0000 and the other probabilities in the row sum. This estimate was of no direct interest, other than as a balancing item.

28/ See footnote 11.

29/ Projections of Educational Statistics, 1965 ed., table 25, p.34.

30/ Sources: enrollments--Ibid., table 4, p. 7; probabilities--.0074 (male); .0042 (female).